PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-203392
(43)Date of publication of application : 27.07.2001

(51)Int.Cl. H01L 33/00

(21)Application number : 2000-009619
(22)Date of filing : 19.01.2000

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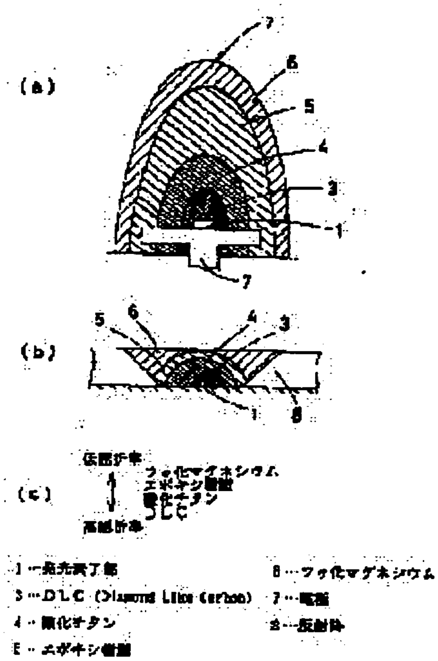
(54) LIGHT-EMITTING DIODE

(57)Abstract:
PROBLEM TO BE SOLVED: To suppress loss of optical flux from the inside of a s miconductor of a light-emitting element, allowing effective guiding of the flux to the outside of a sealing resin.
SOLUTION: Related to a light-emitting diode where a light-emitting element 1 is s aled, the light-emitting element 1 is enclosed with an insulating high-refractive material (DLC3) whose refractive index is at least higher than that of an epoxy resin 5, so that no gap is formed with the light-emitting lement 1. Here, the refractive index of material is decreased as one proceeds outward, forming an optically gradient functional film 2 comprising r fractive index which changes continuously or stepwise. Thus, the diff rence in the refractive index can be decreased between a s miconductor forming the light-emitting element 1 whose refractive index is very high and the material contacting the light-emitting element 1. So, the total r flection is difficult to occurs with the light from the inside of a semiconductor, allowing the light from the light- emitting element 1 to be effectively guided outside, for improved total light flux quantity.



LEGAL STATUS

[Dat of request for examination]

[Date of sending the examiner's decision of rejection]

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[Dat of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] Light emitting diode characterized by forming an optical inclination functional film with a refractive index which is gradually [continuously or] different by making the refractive index of material low as a refractive index is higher than an epoxy resin at least, the aforementioned light-emitting-device section is surrounded with high refraction material with an insulating property and it goes outside so that it may be the light emitting diode which closed the light-emitting-devic s ction and a crevice may not be formed between the aforementioned light-emitting-device sections.

[Claim 2] Light emitting diode characterized by the refractive index having been high, having been the light emitting diode which closed the light-emitting-device section, having surrounded the aforementioned light-emitting-device section with high refraction material with an insulating property rather than the epoxy resin at least so that a front face might be touched, and forming the periphery section with the material of a refractive index lower than the aforementioned quantity refraction material.

[Claim 3] It is the light emitting diode characterized by having at least one-fold [of this low refraction material] or mor while being the light emitting diode which closed the light-emitting-device section by the resin and applying a low refracti n material at least with a refractive index lower than a closure resin to a closure resin front face, and an outside making a r fractiv index low.

[Claim 4] High refraction material is light emitting diode according to claim 1 or 2 which is DLC.

[Claim 5] Light emitting diode according to claim 2 in which the epoxy resin was formed on the outside of high refracti n material.

[Claim 6] Light emitting diode according to claim 1 which carried out the laminating of the titanium-chloride, epoxy resin, and magnesium fluoride to the outside of high refraction material.

[Claim 7] Light emitting diode according to claim 1 which made the optical inclination functional film the lens configuration.

[Translation done.]

DETAILED DESCRIPTION

[D tailed Description of the Invention]
[0001]
[Th technical field to which invention belongs] This invention relates to the light emitting diode which has the closure structur which raises the drawing efficiency of light from the light-emitting-device section.
[0002]
[D scription of the Prior Art] The conceptual diagram showing the shell type light emitting diode of the former [drawing 5], the perspective diagram in which drawing 6 (a) shows the conventional module type light emitting diode, and (b) are th important section expanded sectional view. As shown in drawing 5 , at the conventional light emitting diode, the light-emitting-device section 50 is closed by the epoxy resin 51. Moreover, in drawing 6 , the light-emitting-device section 50 is arranged to opening of the reflective frame 52, and it is closing by the epoxy resin 51.
[0003]
[Problem(s) to be Solved by the Invention] However, in the above-mentioned conventional light emitting diode, since th refractive index of the semiconductor which forms the light-emitting-device section 50 was very large and the differenc with the refractive index of the closure material (epoxy resin) which is in contact with the light-emitting-device section 50 was large, about luminescence inside a semiconductor, it was easy to produce total reflection, and the low fault had th drawing efficiency of the flux of light. Moreover, total reflection of what has a bigger light injected out of an epoxy resin than a certain angle was carried out, and it had produced loss inside.
[0004] Therefore, the purpose of this invention is offering the light emitting diode which derives effectively the light sid tak n out from the element the light emitting diode closure structure for suppressing loss of the flux of light from the interior of a semiconductor of the light-emitting-device section, and at once to the closure resin exterior in consideration of the above conventional troubles.
[0005]
[Means for Solving the Problem] The optical inclination functional film with a refractive index which be gradually [continuously or] different by make the refractive index of material low as a refractive index be higher than an epoxy r sin at least , and the aforementioned light emitting device section be surround with high refraction material with an insulating property and it go outside so that the light emitting diode of this invention according to claim 1 may be the light emitting diode which closed the light emitting device section and a crevice may not be form between the aforementioned light mitting device sections in order to solve the above-mentioned technical problem be formed .
[0006] If the refractive index of the semiconductor which generally constitutes the light-emitting-device section is very high and the matter which has touched has a low refractive index, a critical angle will also be small and total reflection will tend to happen. Therefore, by wrapping the light-emitting-device section in the matter with a more high refractive ind x, the angle to which total reflection happens can be enlarged and the flux of light drawing efficiency to the part exterior improves.
[0007] In a claim 1, a refractive index is higher than an epoxy resin at least so that a crevice may not be formed betw n the light-emitting-device sections. Since the optical inclination functional film with a refractive index which is gradually [continuously or] different by making the refractive index of material low was formed as the aforementioned light-emitting-device section was surrounded with high refraction material with an insulating property and it went outside A difference with the refractive index of the material which is in contact with a semiconductor with the very big refractiv index which forms the light-emitting-device section, and the light-emitting-device section can be made small. For this reason, the light which it is hard coming to generate total reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-device section can be effectively led to the exterior, and th amount of total luminous fluxs improves.
[0008] At least, light emitting diode according to claim 2 was the light emitting diode which closed the light-emitting-d vic section, and rather than the epoxy resin, with the high refraction material which a refractive index is high and has an insulating property, it surrounded the aforementioned light-emitting-device section so that a front face might be touched, and it formed the periphery section with the material of a low refractive index from high refraction material.
[0009] Thus, a difference with the refractive index of the material which is in contact with a semiconductor with the v ry big refractive index which forms the light-emitting-device section, and the light-emitting-device section from the epoxy resin at least sinc th light-emitting-device section was surrounded with th high r fraction mat rial which a r fractiv index is high and has an insulating property so that a front face might be touched, and the periphery s ction was formed with the material of a refractiv index low r than high refraction material can be made small. For this r ason, the light which it is hard coming to generate total r fl ction about th light which com s from th interior of a s miconductor outsid , and comes out from th light- mitting-d vice s ction can be effectiv ly led to the xterior, and the amount of total luminous fluxs improves.
[0010] Light emitting diode according to claim 3 was the light emitting diode which clos d the light- mitting-d vic s cti n by the resin, while applying a low refraction material at l ast with a r fractive index low r than a closur resin to th closure resin front fac , it has at l ast one-fold [of this low r fraction material] or mor , and the outside made th r fractive index low.

[0011] Thus, while applying a low r fraction mat rial at least with a r fractive index lower than a closur r sin to a closur resin front fac , since it has at l ast one-fold r more and the outside made the refractive index low, this low r fraction material can inject now to the xterior mor light which was carrying out total refl cti n to th xt rior air layer by th int rface of a closure r sin, and its amount of total luminous fluxs improv s.
[0012] In claims 1 or 2, th high refracti n mat rial of light emitting diode acc rding to claim 4 is DLC. Thus, sinc high r fraction mat rial is DLC (Diamond Lik Carbon), it can use as a material in which a r fractive ind x has insulation highly.
[0013] Light emitting diod according to claim 5 formed the ep xy resin in the outsid of high r fraction mat rial in the claim 2. Thus, since the epoxy resin was formed in th outside of high refraction mat rial, th light which comes out from the light- mitting-device s ction can be l d outside ffectiv ly.
[0014] Light mitting diod according to claim 6 carri d out the laminating of the titanium-chlorid , epoxy resin, and magnesium fluoride to th outside of high refraction mat rial in th claim 1. Thus, a refractive ind x can be made low as it goes outside, since the laminating of the titanium-chloride, epoxy resin, and magnesium fluoride was carried out to the outside of high refraction material, and the light which comes out from the light-emitting-device section can be drawn outsid ffectively.
[0015] Light emitting diode according to claim 7 made the optical inclination functional film the lens configuration in the claim 1. Thus, since the optical inclination functional film was made into the lens configuration, the refractive-index difference in the interface of an exterior air layer decreases, and total reflection decreases very much.
[0016]
[Embodiments of the Invention] The light emitting diode of the form of implementation of the 1st of this invention is explained based on drawing 1 and drawing 2 . Drawing 1 (a) is explanatory drawing in which the cross section of shell type light emitting diode and (b) showed the cross section of module type light emitting diode in the modification of the form of the 1st operation, and (c) showed the refractive index of the optical inclination functional film of the form of the 1st operation with the form of implementation of the 1st of this invention, and explanatory drawing in which drawing 2 shows a flux of light drawing principle.
[0017] As shown in drawing 1 , the light-emitting-device section 1 is surrounded with the high refraction material which a r fractive index is higher than an epoxy resin 5 at least, and has an insulating property so that this light emitting diode may b the structure which closed the light-emitting-device section 1 and a crevice may not be formed between the light- mitting-device sections 1, and the optical inclination functional film 2 with a refractive index which is gradually [continuously or] different by making the refractive index of material low is formed as it goes outside. In this case, in drawing 1 (a), DLC (Diamond Like Carbon)3 is formed as a material which is insulating by high refraction focusing on the light- mitting-device section 1 prepared on the electrode 7, the exterior is accumulated to titanium oxide 4, epoxy resin 5, and magnesium 6 fluoride and an outside, and it is considering as the lens configuration. In drawing 1 (b), light-emitting-d vice section 1, DLC3, titanium oxide 4, epoxy resin 5, and magnesium 6 fluoride is formed like opening of the reflective frame 8. Moreover, one by one, a refractive index becomes low and the refractive index of the magnesium 6 fluoride besides ** is the lowest as are shown in drawing 1 (c), and the refractive index of DLC3 is the highest and goes to titanium oxid 4, an epoxy resin 5, and an outside.
[0018] The flux of light drawing principle of the light emitting diode of the above-mentioned composition is explained. If th refractive index of the semiconductor which constitutes the light-emitting-device section 1 is very high as shown in drawing 2 (a), and the matter B which has touched has a low refractive index, a critical angle will also be small and total r flection will tend to happen. Therefore, as shown in drawing 2 (b), the angle to which total reflection happens can be enlarged by wrapping the light-emitting-device section 1 in the matter A with a more high refractive index (quality of th material), and the flux of light drawing efficiency to the part exterior improves.
[0019] Since a difference with the refractive index of DLC3 which is the closure material which is in contact with a s miconductor with the very big refractive index which forms light emitting diode 1, and the light-emitting-device section 1 can be made small, it is hard coming to generate total reflection with the form of this operation about the light which comes from the interior of a semiconductor outside. For this reason, the light which comes out from the light-emitting-devic s ction 1 can be effectively led to the exterior, the amount of total luminous fluxs improves, and the flux of light drawing ffici ncy from the light-emitting-device section 1 increases.
[0020] Furthermore, since material with a low refractive index forms the outside one by one, the refractive-index differ nc in th interface of the optical inclination functional film 2 which is lens formation material, and an exterior air layer is d cr asing, total reflection decreases very much and the internal reflection loss of it within a resin is almost lost. Thereby, th flux of light loss to an exterior air layer from lens formation material decreases, and it can lead to the exterior eff ctiv ly, without losing the flux of light taken out from the light-emitting-device section 1.
[0021] The light emitting diode of the form of implementation of the 2nd of this invention is explained based on drawing 3 . In th form of implementation of the 2nd of this invention, drawing 3 (a) is the cross section of shell type light emitting diod , and (b) is the cross section of module type light emitting diode in the modification of the form of the 2nd operation.
[0022] As shown in drawing 3 , at least, rather than the epoxy resin, it is the structure which closed the light-emitting-device s ction 1, and this light emitting diode has a high refractive index, with high refraction material with an insulating property, it surrounds the light-emitting-device section 1 so that the front face may be touched, and forms the periphery s ction with the material of a low refractive index by high refraction material. In this case, in drawing 3 (a), it applies t th light emitting diode 1 which formed DLC3 on the lectrode 7 as a high refraction material, and the xt rior is made into the lens configuration using the poxy r sin 5. In drawing 3 (b), the light- mitting-devic s ction 1, DLC3, and th p xy r sin 5 are formed like opening of the reflective fram 8. Mor ov r, th refractive ind x of DLC3 is high r than th r fractiv ind x of an epoxy r sin 5. The flux of light drawing principl of th light emitting diode of th above-mention d composition is th same as that of drawing 2 .
[0023] Since a diff renc with th refractiv index of DLC3 which is the closure material which is in contact with a semiconductor with the v ry big refractiv ind x which forms th light-emitting-d vic s ction 1, and th light- mitting-d vice s ction 1 can be made small, it is hard coming to generat total refl ction with th form of this op ration about the light which comes from the int rior of a semiconductor outside. For this r ason, the light which comes out from the light-

emitting-d vice s ction 1 can b ffectiv ly l d to the ext ri r, th amount of total luminous fluxs improves, and the flux of light drawing ffici ncy from th light- mitting-devic section 1 incr as s.

[0024] Th light mitting di d of the form of impl mentation of th 3rd of this invention is xplain d bas d on drawing 4 . In the form of implem ntation of th 3rd of this inv ntion, drawing 4 (a) is th cross secti n of sh ll typ light emitting diode, and (b) is th cross section of module typ light mitting diode in the modification of the form of the 3rd op ration.

[0025] As shown in drawing 4 , whil this light mitting diode is th structur which clos d th light-emitting-devic s ction 1 by the r sin and a refractiv index applies low plantar-flexion chip box material to a closur r sin front fac from a closure resin at least, it has at l ast one-fold [of this plantar-flexion chip box material] or more, and th utsid mak s the refractive index low. In this cas , using magn sium fluoride as a plantar-flexion chip box material, this is applied to epoxy resin 10 front fac which is a closure r sin, and the lens configuration consists of drawing 4 (a). In drawing 4 (b), light-emitting-devic secti n 1, epoxy r sin 10, and magnesium 11 fluorid is formed like opening of th r flectiv fram 8. Moreover, the refractive index of magnesium 11 fluoride is a low from the refractive index of an epoxy resin 10.

[0026] With the form of this operation, since material with a low refractive index forms the outside, the refractive-ind x diff r nce in the interface of the material (magnesium 11 fluoride) applied to the closure resin (epoxy resin 10) and an ext rior air layer is decreasing, total reflection decreases very much and the internal reflection loss of it within a resin is almost lost. Thereby, reduction of the flux of light loss to an exterior air layer from lens formation material can be aim d at, and a light guide can be effectively carried out to the exterior, without losing the flux of light taken out from the light- mitting-device section 1. Moreover, a surface application is possible at a low cost, and cost performance is high.

[0027] In addition, although the optical inclination functional film 2 was made into four layer structures with the form of the 1st operation, what is necessary is just three or more layers. Moreover, except this is sufficient although DLC was us d as a high refraction material. With the form of the 3rd operation, although magnesium fluoride was used as a low refraction material, except this is sufficient.

[0028]

[Eff ct of the Invention] According to the light emitting diode of this invention according to claim 1, so that a crevice may not be formed between the light-emitting-device sections At least, rather than an epoxy resin, a refractive index is high and the aforementioned light-emitting-device section is surrounded with high refraction material with an insulating property. Since th optical inclination functional film with a refractive index which is gradually [continuously or] different by making th refractive index of material low was formed as it went outside, a difference with the refractive index of the material which is in contact with a semiconductor with the very big refractive index which forms the light-emitting-device secti n, and the light-emitting-device section can be made small. For this reason, the light which it is hard coming to generate t tal reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-d vice section can be effectively led to the exterior, the amount of total luminous fluxs improves, and the flux of light drawing fficiency from the light-emitting-device section increases.

[0029] A difference with the refractive index of the material which according to the light emitting diode of this invention according to claim 2 is in contact with a semiconductor with the very big refractive index which forms the light-emitting-devic section, and the light-emitting-device section from the epoxy resin at least since the light-emitting-device secti n was surrounded with the high refraction material which a refractive index is high and has an insulating property so that a front fac might be touched, and the periphery section was formed with the material of a refractive index lower than high refraction material can be made small. For this reason, the light which it is hard coming to generate total reflection about the light which comes from the interior of a semiconductor outside, and comes out from the light-emitting-device section can b effectively led to the exterior, the amount of total luminous fluxs improves, and the flux of light drawing efficiency from the light-emitting-device section increases.

[0030] According to the light emitting diode of this invention according to claim 3, while a refractive index applies low plantar-flexion chip box material to a closure resin front face from a closure resin at least, since it has at least one-fold or more and the outside made the refractive index low, this plantar-flexion chip box material can inject now to the exterior more light which was carrying out total reflection to the exterior air layer by the interface of a closure resin, and its amount of total luminous fluxs improves. Moreover, since a surface application at a simple process is possible for plantar-flexion chip box material, cost performance is high.

[0031] Since high refraction material is DLC, light emitting diode according to claim 4 can be used as a material in which a refractiv index has insulation highly.

[0032] In a claim 5, since the epoxy resin was formed in the outside of high refraction material, the light which comes ut from the light-emitting-device section can be led outside effectively.

[0033] A refractive index can be made low as it goes outside by the claim 6, since the laminating of the titanium-chloride, poxy resin, and magnesium fluoride was carried out to the outside of high refraction material, and the light which comes out from the light-emitting-device section can be drawn outside effectively.

[0034] In a claim 7, since the optical inclination functional film was made into the lens configuration, the refractive-ind x difference in the interface of an exterior air layer decreases, and total reflection decreases very much.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Bri f D scription of the Drawings]
[Drawing 1] (a) is explanatory drawing in which the cross section of shell type light emitting diode and (b) showed the cr ss section of module type light emitting diode in the modification of the gestalt of the 1st operation, and (c) showed the refractive index of the optical inclination functional film of the gestalt of the 1st operation with the gestalt of implementation of the 1st of this invention.
[Drawing 2] It is explanatory drawing showing a flux of light drawing principle.
[Drawing 3] In the gestalt of implementation of the 2nd of this invention, (a) is the cross section of shell type light emitting diode, and (b) is the cross section of module type light emitting diode in the modification of the gestalt of the 2nd operation.

[Drawing 4] In the gestalt of implementation of the 3rd of this invention, (a) is the cross section of shell type light emitting diode, and (b) is the cross section of module type light emitting diode in the modification of the gestalt of the 3rd operation.

[Drawing 5] It is the conceptual diagram showing the conventional shell type light emitting diode.
[Drawing 6] The perspective diagram in which (a) shows the conventional module type light emitting diode, and (b) are th important section expanded sectional view.
[Description of Notations]
1 Light-Emitting-Device Section
2 Optical Inclination Functional Film
3 DLC
4 Titanium Oxide
5 Ten Epoxy resin
6 11 Magnesium fluoride

[Translation done.]

(19)日本国特許庁(JP)　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開２００１－２０３３９２
(Ｐ２００１－２０３３９２Ａ)
(43)公開日　平成13年7月27日(2001.7.27)

(51)Int.Cl.^{7}	識別記号	ＦＩ	テーマコード゛(参考)
Ｈ０１Ｌ　33/00		Ｈ０１Ｌ　33/00	Ｎ　5F041

審査請求　未請求　請求項の数７　ＯＬ　(全６頁)

(21)出願番号　特願2000-9619(P2000-9619)

(22)出願日　平成12年1月19日(2000.1.19)

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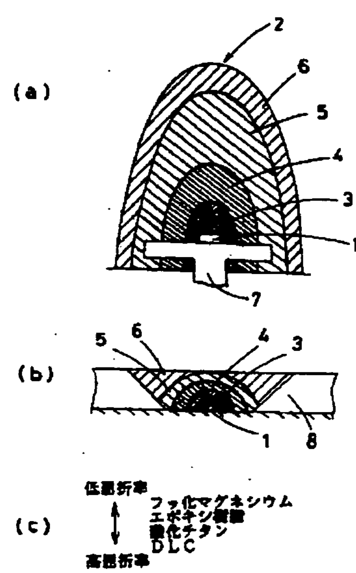
最終頁に続く

(54)【発明の名称】発光ダイオード

(57)【要約】
【課題】　発光素子部の半導体内部からの光束の損失を抑え、封止樹脂外部へ有効に導出する。
【解決手段】　発光素子部１を封止した発光ダイオードであって、発光素子部１との間に隙間が形成されないように、少なくともエポキシ樹脂５よりも屈折率が高く、絶縁特性を持つ高屈折材料（ＤＬＣ３）で発光素子部１を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜２を形成した。これにより、発光素子部１を形成している屈折率が非常に大きな半導体と発光素子部１に接している材質の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部１から出てくる光を有効に外部へ導くことができ、全光束量が向上する。



1…発光素子部
3…ＤＬＣ (Diamond Like Carbon)
4…酸化チタン
5…エポキシ樹脂
6…フッ化マグネシウム
7…電極
8…反射枠

【特許請求の範囲】
【請求項１】　発光素子部を封止した発光ダイオードであって、前記発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成したことを特徴とする発光ダイオード。
【請求項２】　発光素子部を封止した発光ダイオードであって、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を表面に接するように囲み、前記高屈折材料より低い屈折率の材料で外周部を形成したことを特徴とする発光ダイオード。
【請求項３】　発光素子部を樹脂で封止した発光ダイオードであって、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも１重以上有し、外側ほど屈折率を低くしたことを特徴とする発光ダイオード。
【請求項４】　高屈折材料はＤＬＣである請求項１または２記載の発光ダイオード。
【請求項５】　高屈折材料の外側にエポキシ樹脂を形成した請求項２記載の発光ダイオード。
【請求項６】　高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層した請求項１記載の発光ダイオード。
【請求項７】　光学的傾斜機能膜をレンズ形状にした請求項１記載の発光ダイオード。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、発光素子部から光の取出し効率を向上させる封止構造を有する発光ダイオードに関するものである。
【０００２】
【従来の技術】図５は従来の砲弾型発光ダイオードを示す概念図、図６（ａ）は従来のモジュール型発光ダイオードを示す斜視図、（ｂ）はその要部拡大断面図である。図５に示すように、従来の発光ダイオードでは、発光素子部５０をエポキシ樹脂５１で封止している。また、図６では反射枠５２の開口部に発光素子部５０を配置してエポキシ樹脂５１で封止している。
【０００３】
【発明が解決しようとする課題】しかしながら、上記従来の発光ダイオードでは、発光素子部５０を形成している半導体の屈折率は非常に大きく、発光素子部５０に接している封止材料（エポキシ樹脂）の屈折率との差が大きいため、半導体内部での発光については全反射が生じ易く、光束の取出し効率が低い欠点があった。また、エポキシ樹脂外へ射出される光は、ある角度より大きなものは全反射され内部で損失を生じていた。
【０００４】したがって、この発明の目的は、上記のような従来の問題点を考慮して、発光素子部の半導体内部からの光束の損失を抑えるための発光ダイオード封止構造および一度素子から取り出された光側を封止樹脂外部へ有効に導出する発光ダイオードを提供することである。
【０００５】
【課題を解決するための手段】上記課題を解決するためにこの発明の請求項１記載の発光ダイオードは、発光素子部を封止した発光ダイオードであって、前記発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成した。
【０００６】一般に発光素子部を構成している半導体の屈折率は非常に高く、接している物質が屈折率が低ければ臨界角も小さく全反射が起こり易い。そのため、より屈折率の高い物質で発光素子部を包むことで、全反射の起こる角度を大きくでき、その分外部への光束取出し効率が向上する。
【０００７】請求項１では、発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上する。
【０００８】請求項２記載の発光ダイオードは、発光素子部を封止した発光ダイオードであって、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を表面に接するように囲み、高屈折材料より低い屈折率の材料で外周部を形成した。
【０００９】このように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部を表面に接するように囲み、高屈折材料より低い屈折率の材料で外周部を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上する。
【００１０】請求項３記載の発光ダイオードは、発光素子部を樹脂で封止した発光ダイオードであって、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも１重以上有し、外側ほど屈折率を低くした。

【００１１】このように、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも１重以上有し、外側ほど屈折率を低くしたので、外部空気層と封止樹脂の界面で全反射していた光をより多く外部へ射出できるようになり、全光束量が向上する。

【００１２】請求項４記載の発光ダイオードは、請求項１または２において、高屈折材料はＤＬＣである。このように、高屈折材料はＤＬＣ（Diamond Like Carbon）であるので、屈折率が高く絶縁性のある材料として用いることができる。

【００１３】請求項５記載の発光ダイオードは、請求項２において、高屈折材料の外側にエポキシ樹脂を形成した。このように、高屈折材料の外側にエポキシ樹脂を形成したので、発光素子部から出てくる光を有効に外部に導くことができる。

【００１４】請求項６記載の発光ダイオードは、請求項１において、高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層した。このように、高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層したので、外側へいくに従い屈折率を低くすることができ、発光素子部から出てくる光を有効に外部に導くことができる。

【００１５】請求項７記載の発光ダイオードは、請求項１において、光学的傾斜機能膜をレンズ形状にした。このように、光学的傾斜機能膜をレンズ形状にしたので、外部空気層の界面での屈折率差は少なくなり、全反射は非常に少なくなる。

【００１６】

【発明の実施の形態】この発明の第１の実施の形態の発光ダイオードを図１および図２に基づいて説明する。図１（ａ）はこの発明の第１の実施の形態で砲弾型発光ダイオードの断面図、（ｂ）は第１の実施の形態の変形例でモジュール型発光ダイオードの断面図、（ｃ）は第１の実施の形態の光学的傾斜機能膜の屈折率を示した説明図、図２は光束取出し原理を示す説明図である。

【００１７】図１に示すように、この発光ダイオードは、発光素子部１を封止した構造で、発光素子部１との間に隙間が形成されないように、少なくともエポキシ樹脂５よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部１を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜２を形成している。この場合、図１（ａ）では電極７上に設けた発光素子部１を中心に、高屈折で絶縁性のある材料としてＤＬＣ（Diamond Like Carbon）３を形成し、その外部を酸化チタン４、エポキシ樹脂５、フッ化マグネシウム６と外側へ積み上げ、レンズ形状としている。図１（ｂ）では反射枠８の開口部に同様に発光素子部１、ＤＬＣ３、酸化チタン４、エポキシ樹脂５、フッ化マグネシウム６を形成している。また、図１（ｃ）に示すように、ＤＬＣ３の屈折率が最も高く、酸化チタン４、エポキシ樹脂５と外側へいくに従い順次屈折率が低くなり、最外のフッ化マグネシウム６の屈折率が最も低くなっている。

【００１８】上記構成の発光ダイオードの光束取出し原理について説明する。図２（ａ）に示すように発光素子部１を構成している半導体の屈折率は非常に高く、接している物質Ｂが屈折率が低ければ臨界角も小さく全反射が起こり易い。そのため、図２（ｂ）に示すようにより屈折率の高い物質（材質）Ａで発光素子部１を包むことで、全反射の起こる角度を大きくでき、その分外部への光束取出し効率が向上する。

【００１９】この実施の形態では、発光ダイオード１を形成している屈折率が非常に大きな半導体と発光素子部１に接している封止材料であるＤＬＣ３の屈折率との差を小さくできるため、半導体内部から外へ出る光について全反射が生じにくくなる。このため、発光素子部１から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部１からの光束取出し効率が増加する。

【００２０】さらに、順次屈折率の低い材料が外側を形成しているため、レンズ形成材である光学的傾斜機能膜２と外部空気層の界面での屈折率差は少なくなることで、全反射は非常に少なくなり樹脂内での内部反射損失がほとんどなくなる。これにより、レンズ形成材から外部空気層への光束損失が低減し、発光素子部１より取出された光束を損失することなく、有効に外部へ導くことができる。

【００２１】この発明の第２の実施の形態の発光ダイオードを図３に基づいて説明する。図３（ａ）はこの発明の第２の実施の形態で砲弾型発光ダイオードの断面図、（ｂ）は第２の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【００２２】図３に示すように、この発光ダイオードは、発光素子部１を封止した構造で、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部１をその表面に接するように囲み、高屈折材料により低い屈折率の材料で外周部を形成している。この場合、図３（ａ）では高屈折材料としてＤＬＣ３を電極７上に設けた発光ダイオード１へ塗布し、その外部をエポキシ樹脂５を用いてレンズ形状としている。図３（ｂ）では反射枠８の開口部に同様に発光素子部１、ＤＬＣ３、エポキシ樹脂５を形成している。また、ＤＬＣ３の屈折率はエポキシ樹脂５の屈折率より高い。上記構成の発光ダイオードの光束取出し原理は図２と同様である。

【００２３】この実施の形態では、発光素子部１を形成している屈折率が非常に大きな半導体と発光素子部１に接している封止材料であるＤＬＣ３の屈折率との差を小さくできるため、半導体内部から外へ出る光について全

反射が生じにくくなる。このため、発光素子部１から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部１からの光束取出し効率が増加する。

【００２４】この発明の第３の実施の形態の発光ダイオードを図４に基づいて説明する。図４（ａ）はこの発明の第３の実施の形態で砲弾型発光ダイオードの断面図、（ｂ）は第３の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【００２５】図４に示すように、この発光ダイオードは、発光素子部１を樹脂で封止した構造で、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも１重以上有し、外側ほど屈折率を低くしている。この場合、図４（ａ）では低屈折材料としてフッ化マグネシウムを用い、これを封止樹脂であるエポキシ樹脂１０表面へ塗布してレンズ形状を構成している。図４（ｂ）では反射枠８の開口部に同様に発光素子部１、エポキシ樹脂１０、フッ化マグネシウム１１を形成している。また、フッ化マグネシウム１１の屈折率はエポキシ樹脂１０の屈折率より低い。

【００２６】この実施の形態では、屈折率の低い材料が外側を形成しているため、封止樹脂（エポキシ樹脂１０）に塗布した材料（フッ化マグネシウム１１）と外部空気層の界面での屈折率差は少なくなることで、全反射は非常に少なくなり樹脂内での内部反射損失がほとんどなくなる。これにより、レンズ形成材から外部空気層への光束損失の低減を図ることができ、発光素子部１より取出された光束を損失することなく、有効に外部へ導光できる。また、低コストで表面塗布可能でありコストパフォーマンスが高い。

【００２７】なお、第１の実施の形態では、光学的傾斜機能膜２を４層構造としたが、３層以上であればよい。また、高屈折材料としてＤＬＣを用いたがこれ以外でもよい。第３の実施の形態では、低屈折材料としてフッ化マグネシウムを用いたがこれ以外でもよい。

【００２８】

【発明の効果】この発明の請求項１記載の発光ダイオードによれば、発光素子部との間に隙間が形成されないように、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で前記発光素子部を囲み、外側へいくに従い材料の屈折率を低くすることで連続的、もしくは段階的に異なる屈折率を持つ光学的傾斜機能膜を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部からの光束取出し効率が増加する。

【００２９】この発明の請求項２記載の発光ダイオードによれば、少なくともエポキシ樹脂よりも屈折率が高く、絶縁特性を持つ高屈折材料で発光素子部を表面に接するように囲み、高屈折材料より低い屈折率の材料で外周部を形成したので、発光素子部を形成している屈折率が非常に大きな半導体と発光素子部に接している材料の屈折率との差を小さくできる。このため、半導体内部から外へ出る光について全反射が生じにくくなり、発光素子部から出てくる光を有効に外部へ導くことができ、全光束量が向上し、発光素子部からの光束取出し効率が増加する。

【００３０】この発明の請求項３記載の発光ダイオードによれば、封止樹脂表面に少なくとも封止樹脂より屈折率が低い低屈折材料を塗布するとともに、この低屈折材料は少なくとも１重以上有し、外側ほど屈折率を低くしたので、外部空気層と封止樹脂の界面で全反射していた光をより多く外部へ射出できるようになり、全光束量が向上する。また、低屈折材料は簡易な工程で表面塗布可能であるので、コストパフォーマンスが高い。

【００３１】請求項４記載の発光ダイオードは、高屈折材料はＤＬＣであるので、屈折率が高く絶縁性のある材料として用いることができる。

【００３２】請求項５では、高屈折材料の外側にエポキシ樹脂を形成したので、発光素子部から出てくる光を有効に外部に導くことができる。

【００３３】請求項６では、高屈折材料の外側に塩化チタン、エポキシ樹脂、フッ化マグネシウムを積層したので、外側へいくに従い屈折率を低くすることができ、発光素子部から出てくる光を有効に外部に導くことができる。

【００３４】請求項７では、光学的傾斜機能膜をレンズ形状にしたので、外部空気層の界面での屈折率差は少なくなり、全反射は非常に少なくなる。

【図面の簡単な説明】

【図１】（ａ）はこの発明の第１の実施の形態で砲弾型発光ダイオードの断面図、（ｂ）は第１の実施の形態の変形例でモジュール型発光ダイオードの断面図、（ｃ）は第１の実施の形態の光学的傾斜機能膜の屈折率を示した説明図である。

【図２】光束取出し原理を示す説明図である。

【図３】（ａ）はこの発明の第２の実施の形態で砲弾型発光ダイオードの断面図、（ｂ）は第２の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【図４】（ａ）はこの発明の第３の実施の形態で砲弾型発光ダイオードの断面図、（ｂ）は第３の実施の形態の変形例でモジュール型発光ダイオードの断面図である。

【図５】従来の砲弾型発光ダイオードを示す概念図である。

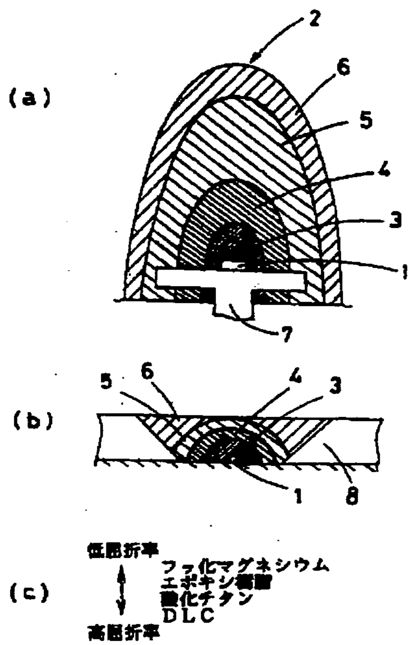
【図６】（ａ）は従来のモジュール型発光ダイオードを示す斜視図、（ｂ）はその要部拡大断面図である。

【符号の説明】

１　発光素子部
２　光学的傾斜機能膜
３　ＤＬＣ

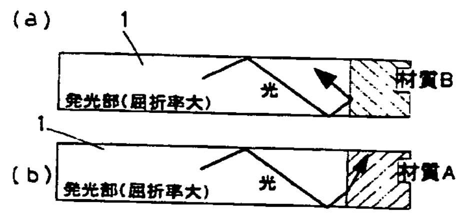
４　酸化チタン
５，１０　エポキシ樹脂
６，１１　フッ化マグネシウム

【図１】

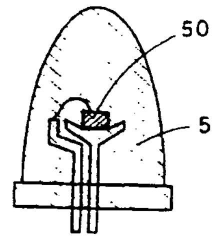


1…発光素子部
3…ＤＬＣ（Diamond Like Carbon）
4…酸化チタン
5…エポキシ樹脂
6…フッ化マグネシウム
7…電極
8…反射枠

【図２】

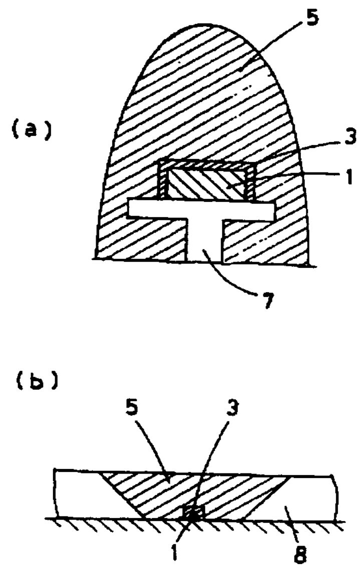


【図５】

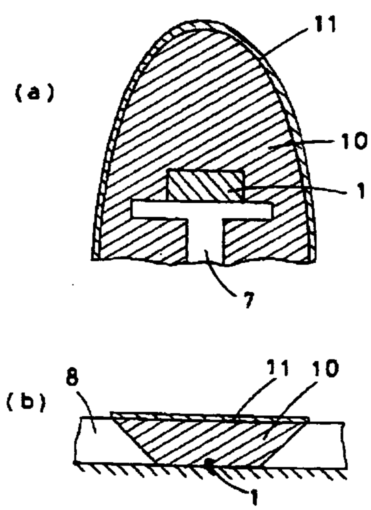


５０…発光素子部
５１…エポキシ樹脂

【図３】

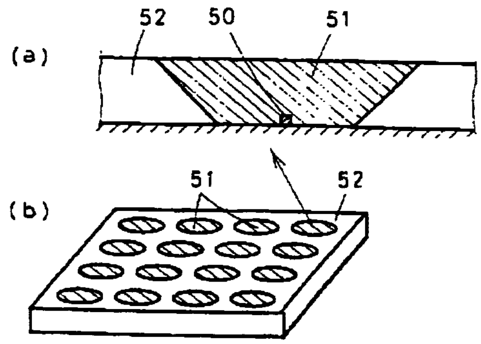


【図４】



1…発光素子部
7…電極
8…反射枠
１０…エポキシ樹脂
１１…フッ化マグネシウム

【図６】



５０…発光素子部
５１…エポキシ樹脂
５２…反射枠

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Ｆターム(参考)　5F041 AA03 AA06 DA19 DA36 DA44 DA46 DA57 DA58 DB01